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THE FOOD HABITS OF CALIFORNIA SEA LIONS AT SAN CLEMENTE ISLAND, CALIFORNIA; APRIL 1983 THROUGH SEPTEMBER 1985

By

Mark S. Lowry, C.W. Oliver and J.B. Wexler

ADMINISTRATIVE REPORT LJ-86-33

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AT SAN CLEMENTE ISLAND, CALIFORNIA:
April 1983 through September 1985

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ABSTRACT

We studied the food habits of the California sea lion (Zalophus californianus) at a rookery on San Clemente Island, California, by collecting 849 scats (i.e., fecal material) from April 1983 through September 1985. We identified prey to the lowest taxonomic level possible from fish otoliths, cephalopod beak mandibles, and other prey remains we recovered from scats. This included 34 prey to species level, five prey to genus, and six prey to family. The most common prey were northern anchovy (Engraulis mordax), pelagic red crab (Pleuroncodes planipes), rockfish (Sebastes spp.), Pacific whiting (Merluccius productus), jack mackerel (Trachurus symmetricus), blacksmith (Chromis punctipinnis), and Pacific mackerel (Scomber japonicus). The presence of these commonly occurring prey in the scats varied both annually and seasonally.

INTRODUCTION

Food habits studies of California sea lions (Zalophus californianus) at San Clemente Island (SCI), California, were initiated in September 1981 to identify prey consumed and to document changes in prey composition over time. From September Lowry and Oliver (1986) reported finding seven prey that commonly occurred in the diet of sea lions: jack mackerel, Trachurus symmetricus; northern anchovy, Engraulis mordax; market squid, Loligo opalescens; Pacific whiting, Merluccius productus; Pacific mackerel, Scomber japonicus; rockfish, Sebastes spp.; and blacksmith, Chromis punctipinnis. Three of the seven prey (jack mackerel, northern anchovy, and market squid) occurred more frequently than other prey and all varied through time in the diet of sea lions. Twenty-six other prey (identified to species, genus, or family) were found in the scats.

This report is an extension of the California sea lion food-habits study from September 1981 through March 1983 conducted at SCI by Lowry and Oliver (1986); this report covers the period from April 1983 through September 1985. This period was characterized by an abnormal influx of warm water into the Southern California Bight, where SCI is located, caused by the 1982-1983 El Niño/Southern Oscillation (McGowan, 1984). The effects of this El Niño on the Southern California Bight became

evident in October 1982 when water in this area was 2 to 4 degrees Fahrenheit above normal (McGowan, 1984). Another effect of the El Nino was the biological changes, such as reduced zooplankton levels, which accompanied the warm-water intrusion (McGowan, 1984). Water temperatures returned to normal in October-November 1984 (F. Miller, pers. commun.).

METHODS

Lowry and Oliver (1986) and Lowry (1986) present a thorough description of the study area and procedures used for (1) scat collection; (2) scat processing; (3) prey identification; and (4) computation of three indices --percent occurrence (PO), percent prey composition (PPC), and percent minimum number (PMN)-- used to quantify differences between prey found in scat samples. We collected sea lion scats from areas of the rookery at and near Mail Point, SCI from April 1983 through September 1985. Each scat was individually soaked in a mild soap solution for one-to-five days and then washed with water through two nested sieves with a mesh size of 2.8 mm² and 0.710 mm². After rinsing we collected all fish otoliths and cephalopod beak mandibles to identify and quantify fish and cephalopods in the diet. Additionally, (1) fragments of pelagic red crabs (Pleuroncodes planipes) were recorded as present or absent in each scat sample; (2) shark teeth were collected and used for identification; and (3) vertebrae from cartilaginous fishes were collected and noted when present.

All data were keypunched, edited, and archived in a computer database (Lowry, 1986). We used the computer software programs described by Lowry (1986) to compute three indices described by Lowry and Oliver (1986): (1) percent occurrence (PO); (2) percent prey composition (PPC), and (3) percent minimum number (PMN). These indices were computed for each prey found in the combined sample of all scats collected from April 1983 through September 1985 and for the scat samples of each collection period.

From April 1983 through September 1985, we made 20 trips to SCI to collect scat samples. The trips were spaced approximately one month apart (see Table 1 for dates of visits). Two three month gaps occurred in our sampling during August through October 1983 and March through May 1985. On each trip we collected fresh and dry scats from the rookery without disturbing the sea lions. Scats collected from each trip were separated into one of three "age" categories: (1) fresh scats; (2) dried scats representing one collection period; and (3) dried scats representing more than one collection period. The fresh scat sample represented the diet of sea lions at the time the scats were collected and possibly as much as 3 to 4 days before the collection date. Dry scats from one collection period were collected from areas we had cleared of scats on a previous visit. These dry scats gave us dietary information from the previous scat collection period to the time represented by fresh scats. Dry scats representing more than one collection period were scats that we collected from areas which had not been cleared on the

previous visit. We did not include these scats in the analysis of the change in the prey composition of the scats over time.

To investigate the changes in prey composition in the scats over time, we used the fresh scats and dry scats that represented one collection period for our analyses. We were not always able to collect fresh scats because, in some cases, the fresh scats were not accessible without disturbing the sea lions. Thus, for some collection periods we had to rely on dry scats for describing the food habits of the sea lions for that period. While there is no doubt as to the time represented by fresh scats, there is uncertainty about the time represented by dry scats. We attempted to minimize this problem by monitoring the areas where scats were collected on every visit to the study site. For periods when we collected only dry scat samples (or very few fresh scat samples), we assumed that these dry scats reflected the diet of the sea lions from the previous collection period, even though some or all may have been deposited just after our departure from the study site during the previous collection period.

We found that the sea lions from SCI consumed a wide variety of prey that could be ranked according to their index values (i.e. PO, PPC and PMN) and by the number of collection periods each occurred. After ranking the prey, we found that nine prey had index values that were distinctly greater than the other prey, or they were present in a larger number of collection periods, or they exhibited seasonal blooms. We divided these species into three prey categories, which we call common prey, uncommon prey, and major prey. We defined common prey as prey that occurred frequently or habitually and were found at a PO level $\geq 10.0\%$ in the combined scat sample, or were present in 80% or more of the collection periods. Uncommon prey were prey that did not meet the criteria for common prey. Major prey were prey which we deemed were greater in importance or rank. We defined major prey as those that had a PO, PPC, and PMN index (when PMN is determined) level $\geq 10.0\%$ in the combined scat sample. The combined scat sample is composed of all scats collected during the present study. We used either the fresh scats or the dry scats that represented one collection period to determine if that prey was present in a collection period.

To examine differences in the prey consumed by sea lions at SCI over time and determine which prey were found consistently over the long term, we examined the three indices for certain prey during each collection period. The prey we chose to examine were (1) commonly occurring prey in the 1981-1983 study (Lowry and Oliver, 1986), (2) those found in 30% or more of all scats from the current study period, or (3) those which exhibited seasonal blooms.

RESULTS

We collected a total of 849 fresh and dry scats during twenty scat sampling collections from April 1983 through

September 1985 (Table 1). Of the 849 scats: (1) 766 scats (90.2%) contained fish otoliths, cephalopod beak mandibles, or other prey remains (e.g. shark teeth and pelagic red crab fragments) that we used for identifying prey; (2) 839 scats (98.8%) contained fish remains (i.e. bones, otoliths, or eye lenses); (3) 735 scats (86.6%) contained fish otoliths; (4) 315 scats (37.1%) contained cephalopod remains (i.e. beak mandibles or eye lenses); and (5) 167 scats (19.7%) contained cephalopod beak mandibles.

All prey were ascertained from the sample of 766 scats which contained prey remains that we used for identification. Positively identified prey, identified to the lowest taxonomic level possible, constituted 93.4% of prey item occurrences. Of 1480 positively identified prey items, we found that 1063 (71.8%) were fish, 255 (17.3%) were pelagic red crab, and 162 (10.9%) were cephalopods. Questionable prey identifications made up 1.6%, and unidentifiable prey accounted for 5.0% of the prey item occurrences (Table 3).

We combined all scat samples collected from April 1983 through September 1985 and calculated PO, PPC, and PMN for all prey found during that time period (Tables 2 and 3). In Tables 2 and 3 we identified and ranked the prey that occurred in the diet of sea lions at SCI, the relative proportions of prey, and the minimum number of individual prey consumed as calculated from the number of fish otoliths or cephalopod beak mandibles. We positively identified 34 prey to species, five prey to genus, and six prey to family (Table 2). Six prey had a PO index level of 10.0% or greater: northern anchovy, pelagic red crab, rockfish, Pacific whiting, jack mackerel, and blacksmith. Three prey had a PO index level between 5.0% and 9.9%: market squid, octopus (Octopus spp.), and Pacific mackerel. The remaining prey had a PO index level of less than 5.0%. We also identified several prey not previously noted (Lowry and Oliver, 1986) as prey of sea lions:

FISHES:

Bigmouth sole (Hippoglossina stomata)
 Blue shark (Prionace glauca)
 Bluespotted poacher (Xeneretmus triacanthus)
 California flying fish (Cypselurus californicus)
 Combfish (Zaniolepis spp.)
 Dogtooth lampfish (Ceratoscopelus townsendi)
 Kelp bass (Paralabrax clathratus)
 Pacific argentine (Argentina sialis)
 Shortspine thornyhead (Sebastolobus alascanus)
 Soupfin shark (Galeorhinus zyopterus)

CEPHALOPODS:

Ocythoe tuberculata.

We determined the common prey and major prey of SCI sea lions during this study period after identifying all the prey from the combined scat sample (Tables 2 and 3) and by examining the prey which were consistently found over the long term (Table 6). Based on our definition of common prey, during the present study period we identified northern anchovy, pelagic red crab, rockfish, Pacific whiting, jack mackerel, and blacksmith as common prey because they occurred in more than 10% of the scat samples, and Pacific mackerel was identified as common prey because it occurred in 80% of the collection periods. From our definition of major prey, we found that northern anchovy, pelagic red crab, and rockfish were major prey.

Of the 849 fresh and dry scats collected, we used 742 to analyze how prey composition changed over time. The samples for the temporal analysis ranged from 12 to 74 fresh or dry scats per collection period, with a mean sample size of 33 scats. Only 669 of these 742 scats (90.2%) contained fish otoliths, cephalopod beak mandibles, or other remains suitable for identifying prey.

We examined nine prey to determine how their occurrence in the diet changed over time: northern anchovy, pelagic red crab, rockfish, Pacific whiting, jack mackerel, blacksmith, octopus, market squid, and Pacific mackerel. The three indices for these prey were computed and tabulated for fresh scats (Table 4), dry scats from one collection period (Table 5), and both combined (Table 6). We found yearly, seasonal, and monthly variability in these nine prey (Tables 4, 5, and 6; Figures 1 and 2). Figure 1 presents the PO and PMN index values for the nine prey and depicts changes in these values for each prey over time for fresh scats, dry scats from one collection period, and both combined. A mean was derived from all collections of the three indices for the nine prey (Table 7). The cumulative graphs of PPC and PMN (Figure 2) plot the principal constituent in the diet of sea lions at certain times of the year, as represented in the combined sample of fresh and dry scats that represented one collection period (Table 6). The PMN cumulative graph does not include pelagic red crab because individual numbers of this prey could not be determined from their exoskeletal fragments in an individual scat. A synopsis of the temporal analysis for the nine prey follows:

1. Northern anchovy (Engraulis mordax) was found at levels above the mean values for the three indices (Table 7) in June 1983, January through early May 1984, March 1985, and June through September 1985. Northern anchovy was the main component in the diet during early spring and summer of 1983, winter and spring of 1984, winter and early spring 1985, and summer and early fall 1985.

2. Pelagic red crab (Pleuroncodes planipes) was found at levels above the mean values for the two indices (Table 7) in April and May 1983, late July 1983, November through December 1983, June through July 1984, and November 1984. Pelagic red crab was a principal component in their diet during the spring of 1983, late fall of 1983 through winter of 1984, summer and fall of 1984, and early spring of 1985.
3. Rockfish (Sebastes spp.) was found at levels above the mean values for the three indices (Table 7) in June 1984, late July 1984 through January 1985. Rockfish was a principal component of the diet from summer through winter of 1984.
4. Pacific whiting (Merluccius productus) was found at levels above the mean values for the three indices (Table 7) from June 1984 through January 1985. Pacific whiting was a principal component of the diet from summer through winter of 1984.
5. Jack mackerel (Trachurus symmetricus) was found at levels above the mean values for the three indices (Table 7) in April and May 1983, November and December 1983, and September 1985. Jack mackerel was a principal component during early fall of 1985; although it occurred often in spring, late fall, and early winter of 1983, and fall of 1984.
6. Blacksmith (Chromis punctipinnis) was found at levels above the mean values for the three indices (Table 7) in May 1983, December 1983, late September 1984, mid November 1984, and June 1985. Blacksmith was a principal component in the diet during late spring of 1983, late summer and fall of 1984, and early summer of 1985.
7. Market squid (Loligo opalescens) was found at levels above the mean values for the three indices (Table 7) in late July 1983, early November 1983, and June 1985 through September 1985. Market squid was a principal component in their diet during the summer of 1985.
8. Octopus (Octopus spp.) was found at levels above the mean values for the three indices (Table 7) in May and June 1984. Octopus was a principal component in the diet during spring and summer of 1984.
9. Pacific mackerel (Scomber japonicus) was found at levels above the mean values for the three indices (Table 7) in May 1983, late July 1983, November and December 1983, June 1984, late July 1984, and January 1985. Pacific mackerel was never a principal component in their diet, though it occurred in the diet throughout the study period.

Other species of fish and cephalopods occurred in our scat samples throughout the study period, but their PO, PPC, and PMN index values were very low compared with the nine prey already described (Tables 2 and 3). In the cumulative graphic representation we examined these other prey species as three groups: (1) other fish species; (2) other cephalopod species; and (3) questionable prey identifications (Figure 2). We found that the group "other fish species" was consistently present in the scats during the study in 1983 and 1984, but it was not represented by large number of individuals. In 1985 the group "other cephalopod species" predominated over the group "other fish species".

We found that the number of prey items occurring in individual scats varied in our scat samples. Of the total sample of 766 scats with identifiable prey items, we found that (1) 47.1% contained one prey item (Figure 4); (2) northern anchovy constituted 57% of the samples with single prey items and the remaining 43% were divided among the remaining prey items found in the diet (Figure 5); and (3) the percent composition of prey items per scat varied between collections during the study period (Table 8).

DISCUSSION

This study has shown that SCI sea lions consume a wide variety of prey items. We identified 34 prey to species and four to genus. Additionally, Lowry and Oliver (1986) found four species that were not found in this study. Therefore, the diet of SCI sea lions includes as many as 38 species and 4 genus of prey. Based on the prey which occurred most often in the scats, we found that sea lions at SCI preferred to feed on schooling fishes (e.g. northern anchovy, jack mackerel, Pacific mackerel, Pacific whiting, blacksmith, and rockfish), schooling cephalopods (e.g. market squid [Hurley, 1978]), and pelagic crustaceans that drift in large swarms (e.g. pelagic red crab [Boyd, 1967]).

Our present definition of common prey differs from that used by Lowry and Oliver (1986) because it includes time as a second element in a new definition of common prey. Lowry and Oliver (1986) defined common prey as any prey with a PO index level $\geq 10\%$ when all scats are combined. In this study we redefined common prey as those prey with a PO level $\geq 10\%$ (Table 2) or that occur in 80% or more of the collection periods. Thus, the new definition of common prey reflects prey that occur frequently in the scat samples or prey that occur habitually in the scat samples through time.

A comparison of results from this study (April 1983 through September 1985) with the previous study at SCI by Lowry and Oliver (1986) for September 1981 through March 1983, indicated similarities and differences between the common and major prey for the two study periods. We applied the new definition of common prey to the results obtained in the 1981-83 study by Lowry and Oliver. Northern anchovy, rockfish, Pacific whiting, jack

mackerel, blacksmith, and Pacific mackerel were noted as common prey for both study periods. Pelagic red crab was not a common prey item during the previous study period, but was found to occur commonly in this study. Although market squid was a common prey (had a PO index level greater than 10%) in the previous study period, in this study it had a PO index of 9.9%. Jack mackerel, northern anchovy, and market squid were major prey in the previous study, and northern anchovy, pelagic red crab, and rockfish were the major prey in the present study.

Extensive shifts, or changes, in the prey consumed by sea lions at SCI occurred over time during our current study (Tables 4, 5, and 6; Figures 1 and 2). Northern anchovy consumption increased in the winter, spring, and mid-summer of 1983, 1984, and 1985. Pelagic red crab consumption increased during the spring and summer of 1983, late fall of 1983 through winter of 1984, summer and late fall of 1984. Pacific whiting and rockfish consumption increased during the summer and fall of 1984, and then disappeared from the diet during the summer of 1985. Consumption of market squid and jack mackerel increased during the summer of 1985. Pacific mackerel and blacksmith consumption by sea lions also varied over time, but was not concentrated in any time period. Octopus consumption increased in late spring through early summer of 1984 and may indicate a seasonal bloom of this prey item which did not occur at other times during our study.

When the data from the September 1981 through March 1983 study (Lowry and Oliver, 1986) and the data from the study reported here are examined together, extensive shifts, or changes, in the prey consumed by sea lions at SCI are also noted. Northern anchovy appears to be the main constituent of their diet during winter and spring, and possibly during mid-summer, although it was found at decreased levels during other times of the year. Jack mackerel and market squid were major prey only in 1982. Rockfish and Pacific whiting were frequently found in the sea lions' diet during the summer and fall of 1984. Although these species were found consistently during 1982 and 1983, consumption was at lower index levels for each prey. Octopus was frequently found in the diet during the late spring and early summer of 1984, but was found in only three scats during the 1981-1983 study. Blacksmith and Pacific mackerel were represented each year, but each was found at low index levels which fluctuated through time. Pelagic red crabs appeared in the sea lions' diet in February 1983 and persisted until August 1985.

Pelagic red crab consumption during 1983-1984 may have been only a short-term phenomenon because this prey first appeared in the diet of sea lions in February 1983 (Lowry and Oliver, 1986) when the El Niño warm water period was affecting the Southern California Bight. Pelagic red crabs are normally found over the continental shelf of southern Baja California and are sometimes transported into the Southern California Bight and further northward by the Davidson and California Countercurrents in January and February (Boyd, 1967). These currents intensified as

a result of the 1982-83 El Niño/Southern Oscillation, and affected water temperatures in the Southern California Bight from late 1982 to October-November 1984. An influx of warm water from these currents caused pelagic red crabs from southern Baja California to inhabit the Southern California Bight during this time. The presence of these crabs in the diet of sea lions from February 1983 to August 1985 reflects the northward transport of crabs into the SCI area. Food habits studies of sea lion populations from southern Baja California, where pelagic red crabs are normally found, may help us understand the significance of this prey item in the diet of the sea lions in the Southern California Bight during the 1982-83 El Niño/Southern Oscillation. If pelagic red crabs were found to be a common prey item of southern Baja California sea lions, then their presence in the diet of SCI sea lions would be a normal response to a favored food item which became available in an area where it is not commonly found. Conversely, if pelagic red crabs are not a common prey item in the diet of southern Baja California sea lions, it may be assumed that SCI sea lions consumed them during the El Niño period due to diminished supplies of their usual prey.

The presence of blacksmith in 12.4% of the scats indicates that some sea lions from SCI feed in shallow areas with rocky substrates or kelpbeds. These fish are normally found in these areas and are known to inhabit rocky crevices at night (Eschmeyer et al., 1983). Blacksmith have also been seen in association with schools of jack mackerel (Feder et al., 1974) which are also a preferred SCI sea lion prey item. Interestingly, blacksmith are rarely found in scats of sea lions from San Nicolas Island (M. Lowry et al., in prep.) and have not been found in sea lion scats from San Miguel Island (Antonelis and Fiscus, 1980; Antonelis et al. 1984).

This study clearly indicates that SCI sea lions feed on a variety of prey, but predominantly select from at least nine species or genera. Northern anchovy appears to be a major source of nourishment because it has been represented by high index values and has consistently occurred in the sea lions' diet during the four year period. Other common prey (i.e. pelagic red crab, jack mackerel, Pacific whiting, rockfish, market squid, blacksmith, and Pacific mackerel) appear to supplement the diet of northern anchovy and may reflect changes in prey abundance or availability between years, seasons, or months. The presence of octopus in the diet during the late spring and early summer of 1984, as well as other species of cephalopods and fishes at other times of the year, indicates that sea lions consume them if available.

Our results of the number of prey per scat may be indicative of sea lion feeding strategy and prey abundance. The high percentage of scats that contained only northern anchovy (Figure 5) may indicate sea lion preference for this species during a feeding bout, ease of capture of this species, or anchovy abundance and availability to SCI sea lions. The rapid

digestive rate for sea lions, approximately 4.2 hours (Helm, 1984), could reduce the chance of recovering prey remains from separate feedings. Multiple prey items found per individual scat samples, may indicate: (1) digestive mixing of two or more feeding bouts; (2) feeding on mixed schools; (3) feeding on individual prey that are not schooling; (4) foraging on smaller schools of prey or over wider ranges due to limited prey availability; or (5) differences in ease of capture of certain prey by individual sea lions or sea lions in general.

It is evident that the diet of sea lions at SCI is quite variable between years, seasons, and months. The variability may reflect differences in abundance or availability of their common prey over time, or it may reflect prey which are more easily captured if all are abundant or available at the same time period. We must also recognize the 1982-83 El Niño's effect on the Southern California Bight. Alteration of the biota in the region near SCI may explain the high degree of temporal variability in the diet of SCI sea lions. These observed temporal differences in the diet of the sea lions from SCI clearly support long-term food-habits studies of this predator. Erroneous conclusions could easily be made by assuming that results of shorter term studies (e.g. Lowry and Oliver, 1986) reflect the diet of sea lions during all time periods.

A major problem with using scat analysis to study pinniped food habits is that it is not known how these results reflect what was initially consumed by the animals. Data on passage rates and the effects of digestion on prey hard parts for various prey are needed. A captive food habits study on a harbor seal (Phoca vitulina) which was fed herring of three length classes indicated that smaller herring were misrepresented in the scats (da Silva and Neilson, 1985). This type of experiment is needed for sea lions using the prey most commonly found in their diet. A study on captive sea lions that are fed a known amount and size of prey would show where biases exist and may provide correction factors that could be applied to the results of scat analysis of a wild population to obtain an estimate of biomass consumed by sea lions.

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Table 1. Collection periods, dates of collection, and numbers and type of California sea lion scat samples obtained from San Clemente Island, California during April 1983 through September 1985.

COLLECTION PERIOD	DATE OF COLLECTION	FRESH SCATS (N)	DRY SCATS REPRESENTING ONE COLLECTION PERIOD (N)	DRY SCATS REPRESENTING MORE THAN ONE COLLECTION PERIOD (N)	TOTAL NUMBER OF ALL SCATS COLLECTED (N)
17	1983 Apr. 15-17	9	32	26	67
18	1983 May 13-15	17	28	34	79
19	1983 June 25	2	18	0	20
20	1983 July 22-23	4	53	10	67
21	1983 Nov. 4-6	22	56	17	95
22	1983 Dec. 16-18	34	7	2	43
23	1984 Jan. 20-22	27	21	2	50
24	1984 Feb. 24-26	32	23	0	55
25	1984 Mar. 23-25	42	19	8	69
26	1984 May 3-6	39	1	8	48
27	1984 June 15-16	43	0	0	43
28	1984 July 21	25	1	0	26
29	1984 July 26-27	20	0	0	20
30	1984 Sept. 20-22	11	28	0	39
31	1984 Nov. 16	2	12	0	14
32	1985 Jan. 12	0	16	0	16
33	1985 Mar. 9	11	1	0	12
34	1985 June 8	24	0	0	20
35	1985 Aug. 2-5	36	0	0	36
36	1985 Sept. 6-8	26	0	0	26
TOTAL		426	316	107	849

TABLE 2. Occurrence of prey, prey composition, and minimum number of prey determined for positively identified prey found in 766 California sea lion (*Zalophus californianus*) scats collected at San Clemente Island, California during April 1983 through September 1985.

SCIENTIFIC NAME	COMMON NAME	OCCURRENCE			PREY COMPOSITION		MINIMUM NUMBER	
		N SCATS	PO	N OCC	PPC	N	PMN	
<u>Engraulis mordax</u>	northern anchovy	403	52.6	403	25.4	5463	54.9	
<u>Pleuroncodes planipes</u>	pelagic red crab	255	33.3	255	16.1	-	-	
<u>Sebastes spp.</u>	rockfish	160	20.9	160	10.1	990	10.0	
<u>Merluccius productus</u>	Pacific whiting (hake)	140	18.3	140	8.9	1662	16.7	
<u>Trachurus symmetricus</u>	jack mackerel	113	14.8	113	7.1	381	3.8	
<u>Chromis punctipinnis</u>	blacksmith	95	12.4	95	6.0	443	4.5	
<u>Loligo opalescens</u>	market squid	76	9.9	76	4.8	274	2.8	
<u>Octopus spp.</u>	octopus	60	7.8	60	3.8	376	3.8	
<u>Scomber japonicus</u>	Pacific mackerel	55	7.2	55	3.5	86	0.9	
<u>Onychoteuthis borealijaponicus</u>	squid	17	2.2	17	1.1	19	0.2	
MYCTOPHIDAE	lanternfish	15	2.0	15	0.9	28	0.3	
<u>Oxyjulis californica</u>	señorita	9	1.1	9	0.6	15	0.2	
<u>Porichthys notatus</u>	plainfin midshipman	9	1.1	9	0.6	11	0.1	
<u>Sebastolobus alascanus</u>	shortspine thornyhead	6	0.8	6	0.4	7	0.1	
<u>Lyopsetta exilis</u>	slender sole	6	0.8	6	0.4	6	0.1	
<u>Abraaliopsis cf. felis</u>	squid	6	0.8	6	0.4	8	0.1	
<u>Icichthys lockingtoni</u>	medusafish	5	0.7	5	0.3	7	0.1	
<u>Microstomus pacificus</u>	dover sole	5	0.7	5	0.3	7	0.1	
<u>Lycodes cortezianus</u>	bigfin eelpout	5	0.7	5	0.3	6	0.1	
<u>Glyptocephalus zachirus</u>	rex sole	4	0.5	4	0.3	5	0.1	
<u>Citharichthys sordidus</u>	Pacific sanddab	3	0.4	3	0.2	4	<0.1	
<u>Cypselurus californicus</u>	California flying fish	2	0.3	2	0.1	8	0.1	
<u>Semicossyphus pulcher</u>	sheephead	2	0.3	2	0.1	2	<0.1	
<u>Gonatus spp.</u>	squid	2	0.3	2	0.1	2	<0.1	
<u>Xeneretmus ritteri</u>	stripefin poacher	2	0.3	2	0.1	2	<0.1	
<u>Mastigoteuthis pyrodes</u>	squid	2	0.3	2	0.1	2	<0.1	
<u>Galeorhinus zyopterus</u>	soupin shark	2	0.3	2	0.1	-	-	
ZOARCIDAE	eelpout	2	0.3	2	0.1	2	<0.1	
<u>Symbolophorus californiensis</u>	California lanternfish	2	0.3	2	0.1	2	<0.1	
<u>Paralabrax clathratus</u>	kelp bass	2	0.3	2	0.1	2	<0.1	

(Data impossible to compute in fields marked with a dash (-); N OCC = number of occurrences; PO = percent occurrence; and PMN = percent minimum number).

Table 2. (Continued)

SCIENTIFIC NAME	PREY COMMON NAME	OCCURRENCE		PREY COMPOSITION		MINIMUM NUMBER			
		N	SCATS	PO	N	OCC	PPC	N	PMN
EMBIOTOCIDAE	surfperch	1	1	0.1	1	1	0.1	1	<0.1
ATHERINIDAE	silverside	1	1	0.1	1	1	0.1	1	<0.1
COTTIDAE	sculpin	1	1	0.1	1	1	0.1	1	<0.1
Atherinops affinis	topsmelt	1	1	0.1	1	1	0.1	1	<0.1
Ocythoe tuberculata	squid	1	1	0.1	1	1	0.1	2	<0.1
Prionace glauca	blue shark	1	1	0.1	1	1	0.1	-	-
Girella nigricans	opaleye	1	1	0.1	1	1	0.1	2	<0.1
Argentina sialis	Pacific argentine	1	1	0.1	1	1	0.1	1	<0.1
Hippoglossina stomata	bigmouth sole	1	1	0.1	1	1	0.1	1	<0.1
Parophrys vetulus	english sole	1	1	0.1	1	1	0.1	1	<0.1
Xeneretmus triacanthus	bluespotted poacher	1	1	0.1	1	1	0.1	1	<0.1
Ceratoscopelus townsendi	dogtooth lampfish	1	1	0.1	1	1	0.1	4	<0.1
SCOMBRIDAE	mackerel or tuna	1	1	0.1	1	1	0.1	2	<0.1
Citharichthys sp.	sanddab	1	1	0.1	1	1	0.1	1	<0.1
Zaniolepis sp.	combfish	1	1	0.1	1	1	0.1	1	<0.1

(Data impossible to compute in fields marked with a dash (-); N OCC = number of occurrences; PO = percent occurrence; and PMN = percent minimum number).

Table 3. Occurrence of prey, prey composition, and minimum number of prey determined for questionable and unidentified prey identifications found in 766 California sea lion (*Zalophus californianus*) scats collected at San Clemente Island, California during April 1983 through September 1985.

PREY		OCCURRENCE			PREY COMPOSITION		MINIMUM NUMBER	
SCIENTIFIC NAME	COMMON NAME	N	SCATS	PO	N	OCC	PPC	PMN
QUESTIONABLE IDENTIFICATIONS								
<u>Engraulis mordax?</u>	northern anchovy	9	1.1		9		0.6	0.1
<u>Sebastes spp.?</u>	rockfish	4	0.5		4		0.3	0.1
MYCTOPHIDAE?	lanternfish	2	0.3		2		0.1	0.1
<u>Abraliopsis spp.?</u>	squid	2	0.3		2		0.1	<0.1
<u>Trachurus symmetricus?</u>	jack mackerel	2	0.3		2		0.1	<0.1
<u>Chromis punctipinnis?</u>	blacksmith	2	0.3		2		0.1	<0.1
<u>Loligo opalescens?</u>	market squid	1	0.1		1		0.1	<0.1
<u>Merluccius productus?</u>	Pacific whiting (hake)	1	0.1		1		0.1	-
<u>Scomber japonicus?</u>	Pacific mackerel	1	0.1		1		0.1	<0.1
SCOMBRIDAE?	tunas and mackerels	1	0.1		1		0.1	<0.1
EMBIOTOCIDAE?	surfperch	1	0.1		1		0.1	<0.1
UNIDENTIFIED								
UNIDENTIFIED FISHES	"various fish species"	43	5.6		43		2.7	0.4
UNID. CEPHALOPOD	squid/octopus	15	2.0		15		0.9	0.1
UNIDENTIFIED FLATFISH		5	0.7		5		0.3	0.1
UNID. FISH TOOTH	fish	5	0.7		5		0.3	-
cf. <u>Trachurus symmetricus?</u>	jack mackerel?	2	0.3		2		0.1	<0.1
cf. <u>Sebastes spp.?</u>	rockfish?	2	0.3		2		0.1	<0.1
CARTILAGINOUS FISH								
VERTEBRAE								
cf. <u>Lyopsetta exilis?</u>	slender sole	2	0.3		2		0.1	-
cf. <u>Paralabrax clathratus?</u>		1	0.1		1		0.1	<0.1
cf. <u>GONATIDAE?</u>	kelp bass	1	0.1		1		0.1	<0.1
UNID. CRUSTACEAN PARTS	squid	1	0.1		1		0.1	-
UNID. SHARK TOOTH		1	0.1		1		0.1	-

(Data impossible to compute in fields marked with a dash (-); N OCC = number of occurrences; PO = percent occurrence; and PMN = percent minimum number).

Table 4. Occurrence of prey, minimum number of prey, and prey composition for nine prey found in 426 fresh California sea lion (Zalophus californianus) scats collected at San Clemente Island, California during twenty collection periods from April 1983 through September 1985. Dates of collection periods given in Table 1.

PREY	COLLECTION PERIODS																																			
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																
Northern anchovy (<u>Engraulis mordax</u>):																																				
Percent occurrence (PO)	44	27	50	100	27	83	71	77	99	73	32	44	44	0	0	82	57	84	79																	
Percent prey composition (PPC)	33	19	50	33	10	30	53	54	53	32	11	20	15	0	0	53	29	46	56																	
Percent minimum number (PMN)	86	55	100	41	16	54	93	94	92	60	10	26	30	0	0	89	74	79	87																	
Pelagic red crab (<u>Pleuroncodes planipes</u>):																																				
Percent occurrence (PO)	44	20	50	50	57	40	11	15	14	21	56	36	78	0	100	27	13	6	0																	
Percent prey composition (PPC)	33	14	50	17	19	14	9	11	8	11	18	17	25	0	33	18	7	3	0																	
Percent minimum number (PMN)	(Not computable for this prey)																																			
Rockfishes (<u>Sebastes</u> spp.):																																				
Percent occurrence (PO)	0	0	0	25	29	33	8	4	5	18	32	28	39	9	50	0	26	9	0																	
Percent prey composition (PPC)	0	0	0	8	10	12	6	3	3	8	10	13	13	6	17	0	13	5	0																	
Percent minimum number (PMN)	0	0	0	9	9	6	2	<1	3	4	30	6	22	1	60	0	6	1	0																	
Pacific whiting (<u>Merluccius productus</u>):																																				
Percent occurrence (PO)	0	7	0	25	19	17	4	0	0	6	59	56	61	55	50	27	35	16	0																	
Percent prey composition (PPC)	0	5	0	8	6	6	3	0	0	3	19	26	20	33	17	18	18	8	0																	
Percent minimum number (PMN)	0	1	0	1	4	8	<1	0	0	<1	42	66	39	37	20	9	5	2	0																	
Jack mackerel (<u>Trachurus symmetricus</u>):																																				
Percent occurrence (PO)	22	7	0	0	33	17	4	0	8	21	0	4	11	27	0	0	9	9	33																	
Percent prey composition (PPC)	17	5	0	0	11	6	3	0	5	9	0	2	4	17	0	0	4	5	24																	
Percent minimum number (PMN)	12	1	0	0	30	11	<1	0	1	2	0	1	3	4	0	0	<1	3	9																	
Blacksmith (<u>Chromis punctipinnis</u>):																																				
Percent occurrence (PO)	0	33	0	0	14	20	4	12	3	9	10	0	6	55	0	0	30	6	0																	
Percent prey composition (PPC)	0	24	0	0	5	7	3	8	2	4	3	0	2	33	0	0	16	3	0																	
Percent minimum number (PMN)	0	34	0	0	9	5	1	4	<1	3	2	0	1	57	0	0	7	1	0																	

Table 4. (Continued)

Market squid (<u>Loligo opalescens</u>):																							
Percent occurrence (PO)	0	7	0	50	19	3	8	4	5	3	2	0	0	0	0	0	0	13	31	21			
Percent prey composition (PPC)	0	5	0	17	6	1	6	3	3	1	1	0	0	0	0	0	0	7	17	15			
Percent minimum number (PMN)	0	1	0	46	6	<1	1	<1	1	<1	<1	0	0	0	0	0	0	6	10	4			
Octopus (<u>Octopus</u> spp.):																							
Percent occurrence (PO)	0	0	0	0	5	7	0	0	14	49	41	12	17	0	0	0	0	0	0	0	0	0	0
Percent prey composition (PPC)	0	0	0	0	2	2	0	0	8	22	13	6	5	0	0	0	0	0	0	0	0	0	0
Percent minimum number (PMN)	0	0	0	0	1	5	0	0	2	30	13	1	2	0	0	0	0	0	0	0	0	0	0
Pacific mackerel (<u>Scomber japonicus</u>):																							
Percent occurrence (PO)	0	7	0	25	19	10	0	0	5	3	15	4	17	0	0	0	0	4	0	4	0	4	4
Percent prey composition (PPC)	0	5	0	8	6	4	0	0	4	1	5	2	5	0	0	0	0	2	0	3	0	3	3
Percent minimum number (PMN)	0	1	0	1	9	3	0	0	<1	<1	1	<1	1	0	0	0	0	<1	0	<1	0	<1	<1
Sample size (n = scats with prey)	9	15	2	4	21	30	24	26	37	33	41	25	18	11	2	0	11	23	32	24			

Table 5. Occurrence of prey, minimum number of prey, and prey composition for nine prey found in 316 dried scats of California sea lions (*Zalophus californianus*) which were no older than one collection period, and collected at San Clemente Island, California during twenty collection periods from April 1983 through September 1985. Dates of collection periods given in Table 1.

		COLLECTION PERIODS																			
PREY		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Northern anchovy (<u>Engraulis mordax</u>):																					
Percent occurrence (PO)		52	10	81	56	43	17	65	80	100					15	20	50				
Percent prey composition (PPC)		29	4	48	27	18	4	32	59	80					7	7	26				
Percent minimum number (PMN)		77	2	91	61	59	3	89	96	97					5	3	25				
Pelagic red crab (<u>Pleuroncodes planipes</u>):																					
Percent occurrence (PO)		48	50	13	32	49	100	28	15	6					7	80	0				
Percent prey composition (PPC)		27	31	7	15	20	25	15	11	5					4	27	0				
Percent minimum number (PMN)		(Not computable for this prey)																			
Rockfishes (<u>Sebastes</u> spp.):																					
Percent occurrence (PO)		7	29	13	22	25	33	35	20	6					58	30	50				
Percent prey composition (PPC)		4	13	7	10	10	8	17	15	5					28	10	26				
Percent minimum number (PMN)		1	10	2	6	5	25	5	2	<1					32	31	32				
Pacific whiting (<u>Merluccius productus</u>):																					
Percent occurrence (PO)		0	5	6	10	11	17	20	10	0			100		65	60	50				
Percent prey composition (PPC)		0	2	4	5	5	4	10	7	0			100		31	20	26				
Percent minimum number (PMN)		0	31	1	3	3	3	2	<1	0			100		54	32	24				
Jack mackerel (<u>Trachurus symmetricus</u>):																					
Percent occurrence (PO)		30	24	19	12	25	33	5	0	0					12	10	8				
Percent prey composition (PPC)		17	11	11	6	10	8	2	0	0					6	4	4				
Percent minimum number (PMN)		13	23	3	5	11	22	<1	0	0					1	1	9				
Blacksmith (<u>Chromis punctipinnis</u>):																					
Percent occurrence (PO)		15	24	11	8	6	0	5	5	6					12	30	8				
Percent prey composition (PPC)		8	11	7	4	2	0	2	4	5					6	10	4				
Percent minimum number (PMN)		4	19	2	1	3	0	<1	1	2					5	23	8				

Table 5. (Continued)

Market squid (<u>Loligo opalescens</u>):															
Percent occurrence (PO)	11	0	0	28	28	50	0	0	0	0	0	0	0	0	0
Percent prey composition (PPC)	6	0	0	13	12	13	0	0	0	0	0	0	0	0	0
Percent minimum number (PMN)	2	0	0	14	9	19	0	0	0	0	0	0	0	0	0
Octopus (<u>Octopus</u> spp.):															
Percent occurrence (PO)	0	5	6	2	0	0	0	0	0	0	6	8	20	0	0
Percent prey composition (PPC)	0	2	4	1	0	0	0	0	0	0	5	4	7	0	0
Percent minimum number (PMN)	0	1	1	<1	0	0	0	0	0	0	1	1	3	0	0
Pacific mackerel (<u>Scomber japonicus</u>):															
Percent occurrence (PO)	4	14	6	8	8	17	10	0	0	0	0	4	0	8	0
Percent prey composition (PPC)	2	7	4	4	3	4	5	0	0	0	0	2	0	4	0
Percent minimum number (PMN)	2	6	1	1	2	3	1	0	0	0	0	<1	0	1	0
Sample size (n = scats with prey)	27	21	16	50	53	6	20	20	20	16	1	0	1	0	0

Table 6. Occurrence of prey, prey composition, and minimum number of prey for nine prey found in 742 California sea lion scats which were either fresh or dry, but no older than one collection period, and collected at San Clemente Island, California during twenty collection periods from April 1983 through September 1985. Dates of collection periods given in Table 1.

PREY	COLLECTION PERIODS																			
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Northern anchovy (<u>Engraulis mordax</u>):																				
Percent occurrence (PO)	50	17	78	59	39	72	68	78	94	71	34	42	44	11	17	50	75	56	84	79
Percent prey composition (PPC)	30	9	48	27	15	24	41	56	60	32	11	20	15	6	6	26	50	29	46	56
Percent minimum number (PMN)	79	28	91	54	52	49	91	95	93	60	10	24	30	4	2	25	89	74	79	87
Pelagic red crab (<u>Pleuroncodes planipes</u>):																				
Percent occurrence (PO)	47	47	17	33	51	50	20	15	11	23	56	35	78	5	83	0	25	13	6	0
Percent prey composition (PPC)	28	26	10	15	20	17	12	11	7	11	18	16	25	3	28	0	17	7	3	0
Percent minimum number (PMN)	(Not computable for this prey)																			
Rockfishes (<u>Sebastes</u> spp.):																				
Percent occurrence (PO)	6	17	11	22	26	33	20	11	6	18	32	27	39	43	33	50	0	26	9	0
Percent prey composition (PPC)	3	9	7	10	10	11	12	8	4	8	10	13	13	22	11	26	0	13	5	0
Percent minimum number (PMN)	1	5	2	7	6	8	3	1	2	4	30	6	22	26	35	32	0	6	1	0
Pacific whiting (<u>Merluccius productus</u>):																				
Percent occurrence (PO)	0	6	5	11	13	16	11	4	0	6	58	58	61	62	58	50	25	35	16	0
Percent prey composition (PPC)	0	3	3	5	5	6	7	3	0	3	19	27	20	32	19	26	17	18	8	0
Percent minimum number (PMN)	0	16	1	3	3	7	1	<1	0	<1	42	68	39	51	31	24	9	5	2	0

Table 6. (Continued)

<u>Jack mackerel (<i>Trachurus symmetricus</i>):</u>																					
Percent occurrence (PO)	28	17	17	11	27	19	4	0	6	21	0	4	11	16	8	8	0	9	9	33	
Percent prey composition (PPC)	17	9	10	5	10	7	3	0	4	9	0	2	4	8	3	4	0	4	5	24	
Percent minimum number (PMN)	13	12	3	3	15	12	<1	0	<1	2	0	1	3	2	1	9	0	<1	3	9	
<u>Blacksmith (<i>Chronis punctipinnis</i>):</u>																					
Percent occurrence (PO)	11	28	11	7	8	17	4	9	4	9	10	0	5	24	25	8	0	30	6	0	
Percent prey composition (PPC)	7	15	7	3	3	6	3	6	2	4	3	0	2	13	8	4	0	16	3	0	
Percent minimum number (PMN)	3	26	2	1	4	5	1	3	1	3	2	0	1	15	20	8	0	7	1	0	
<u>Market squid (<i>Loligo opalescens</i>):</u>																					
Percent occurrence (PO)	8	3	0	30	26	11	4	2	4	3	2	0	0	0	0	0	0	13	31	21	
Percent prey composition (PPC)	5	2	0	14	10	4	3	2	2	1	1	0	0	0	0	0	0	7	17	15	
Percent minimum number (PMN)	2	1	0	25	9	2	<1	<1	1	<1	0	0	0	0	0	0	0	6	10	4	
<u>Octopus (<i>Octopus</i> spp.):</u>																					
Percent occurrence (PO)	0	3	5	2	1	5	0	0	11	47	41	12	17	5	17	0	0	0	0	0	
Percent prey composition (PPC)	0	2	3	1	1	2	0	0	7	21	13	5	5	3	6	0	0	0	0	0	
Percent minimum number (PMN)	0	1	1	<1	<1	5	0	0	1	30	13	<1	2	1	2	0	0	0	0	0	
<u>Pacific mackerel (<i>Scomber japonicus</i>):</u>																					
Percent occurrence (PO)	3	11	5	9	11	11	4	0	4	3	15	4	17	3	0	8	0	4	0	4	
Percent prey composition (PPC)	2	6	3	4	4	4	3	0	2	1	5	2	5	1	0	4	0	2	0	3	
Percent minimum number (PMN)	2	3	<1	1	3	3	1	0	<1	<1	1	<1	1	<1	0	1	0	<1	0	<1	
Sample size (n = scats with prey)																					
	36	36	18	54	74	36	44	46	53	34	41	26	18	37	12	12	12	23	32	24	

Table 7. Mean index values for nine California sea lion prey taken from 20 scat collections between April 1983 and September 1985 at San Clemente Island, California. The mean of each prey was calculated for Table 6.

	Mean of all collections		
	PO	PPC	PMN
Northern anchovy	56%	28%	56%
Pelagic red crab	31%	14%	?
Rockfish	21%	10%	10%
Pacific hake	25%	10%	10%
Jack mackerel	12%	6%	4%
Blacksmith	11%	5%	5%
Market squid	11%	5%	5%
Octopus	8%	3%	3%
Pacific mackerel	6%	3%	1%

Table 8. Occurrence of single and multiple prey found in individual California sea lion scats collected at San Clemente Island, California from April 1983 through September 1985.

COLLECTION PERIOD	DATE OF COLLECTION	OCCURRENCE (%)					
		NUMBER OF	PREY	PER	INDIVIDUAL	SCAT	
		1	2	3	4	5	>5
17	1983 Apr. 15-17	53	33	11	0	3	0
18	1983 May 13-15	50	28	14	6	3	0
19	1983 June 25	67	11	17	6	0	0
20	1983 July 22-23	43	24	19	9	2	4
21	1983 Nov. 4-6	34	22	19	11	11	4
22	1983 Dec. 16-18	28	19	25	3	14	11
23	1984 Jan. 20-22	64	18	14	2	0	2
24	1984 Feb. 24-26	78	11	4	7	0	0
25	1984 Mar. 23-25	62	23	11	2	2	0
26	1984 May 3-6	38	35	3	18	3	3
27	1984 June 15-16	20	17	29	15	10	10
28	1984 July 21	46	19	19	12	0	4
29	1984 July 26-27	17	17	44	6	11	6
30	1984 Sept. 20-22	43	32	16	3	5	0
31	1984 Nov. 16	25	17	17	25	17	0
32	1985 Jan. 12	50	25	8	17	0	0
33	1985 Mar. 9	58	33	8	0	0	0
34	1985 June 8	39	35	22	0	4	0
35	1985 Aug. 2-5	56	19	19	0	3	3
36	1985 Sept. 6-8	71	21	4	4	0	0

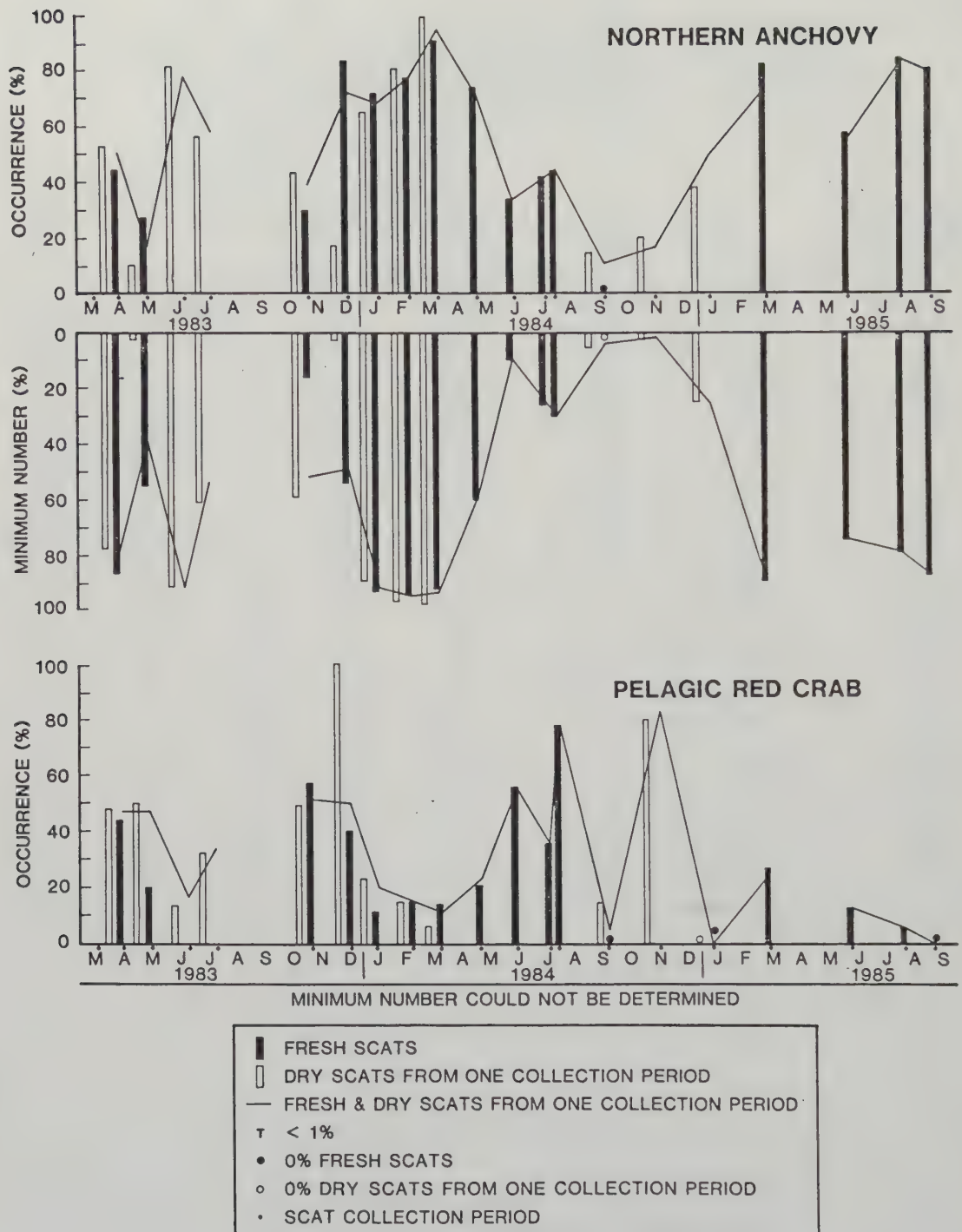


Figure 1. Percent occurrence (PO) and percent minimum number (PMN) of nine prey found in 669 California sea lion scats collected at San Clemente Island, California from April 1983 through September 1985.

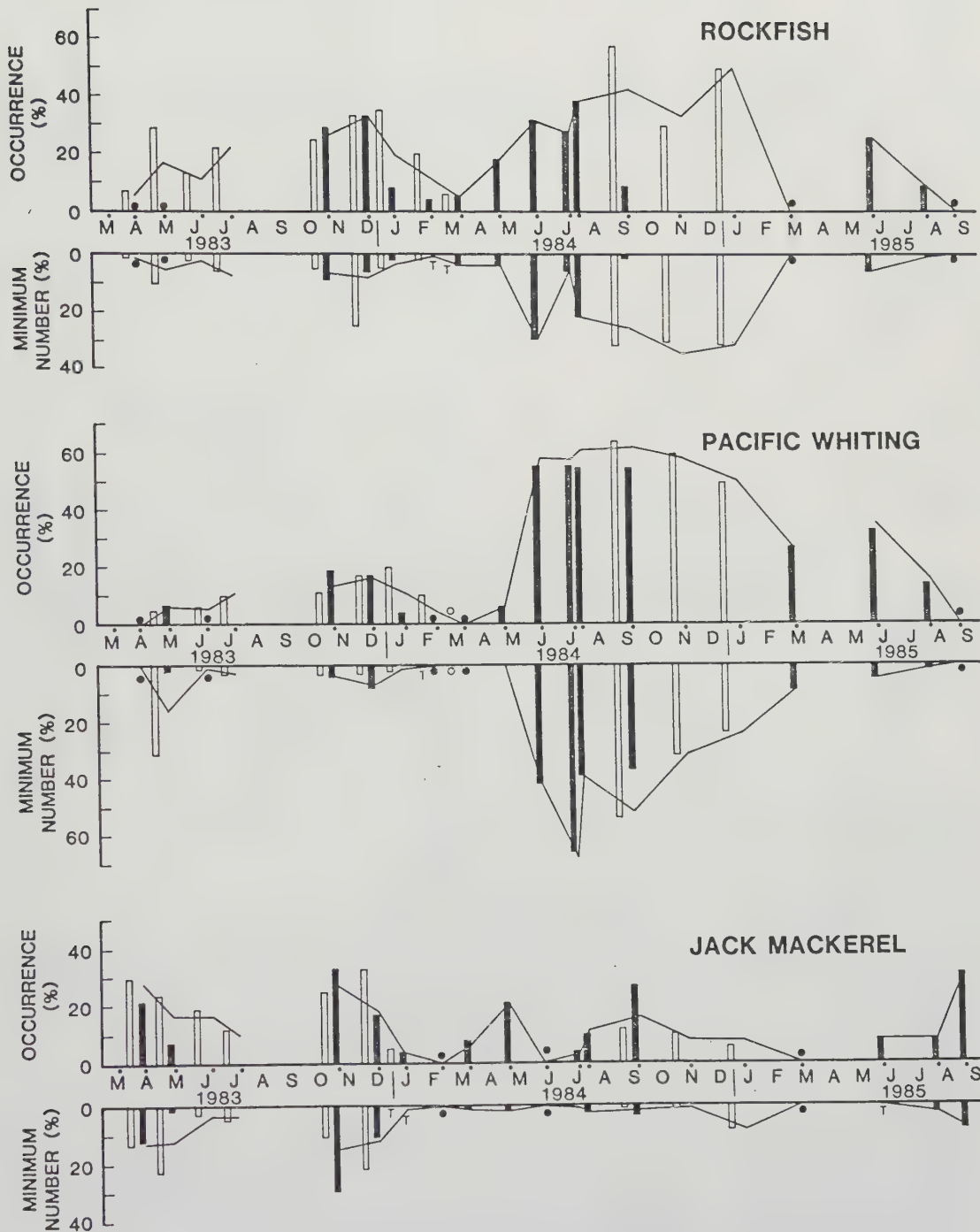


Figure 1. (continued)

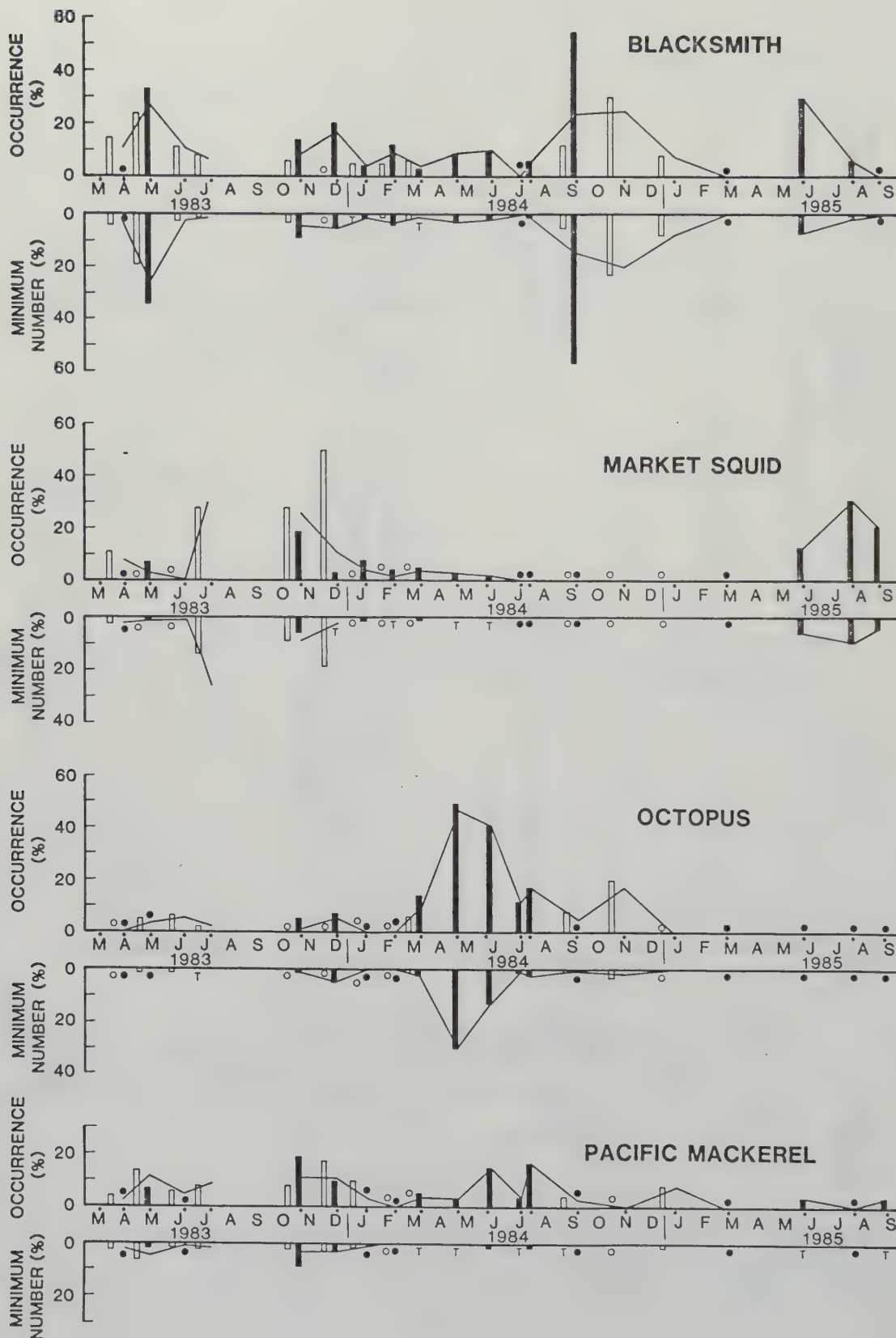


Figure 1. (continued)

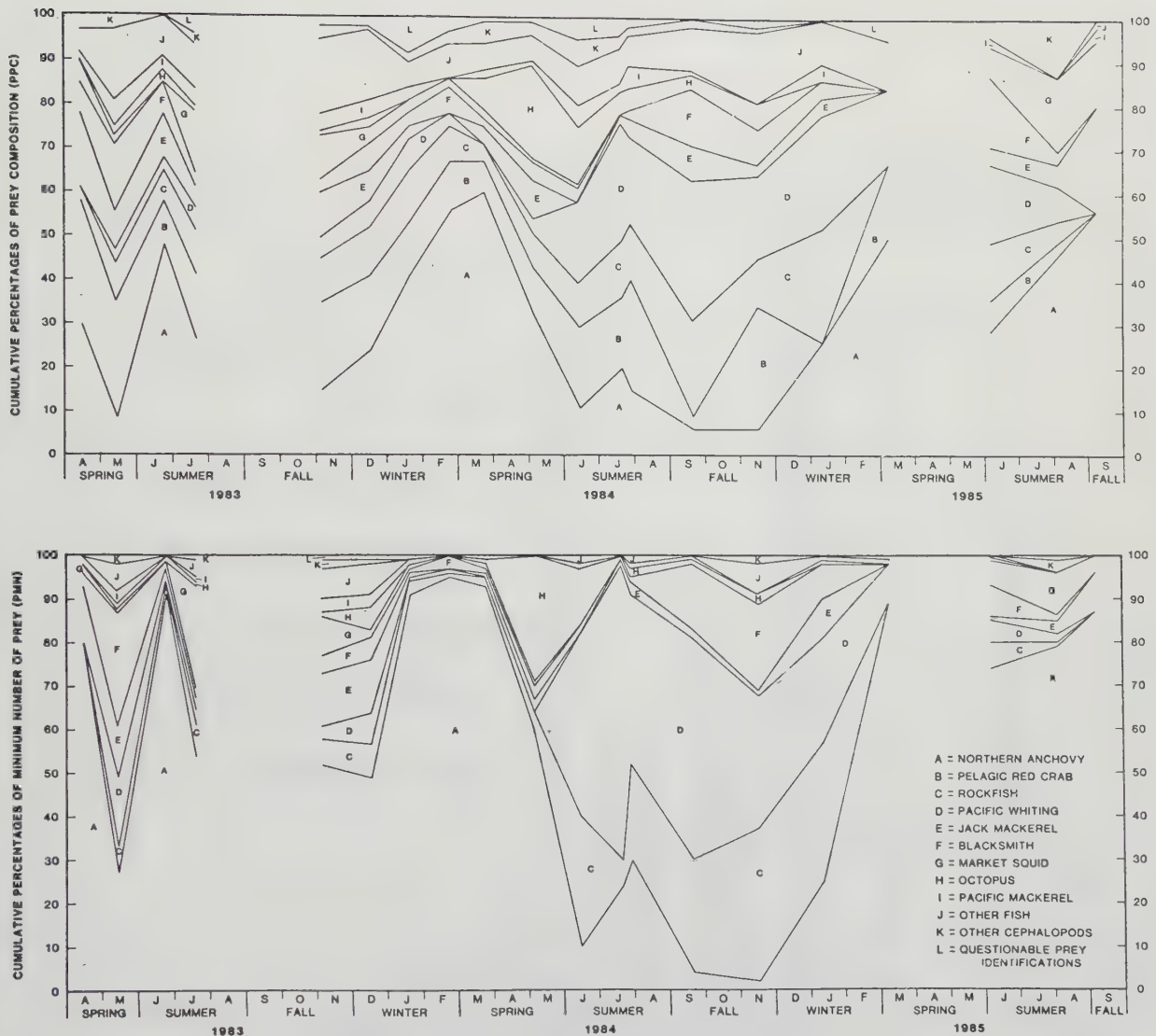


Figure 2. Cumulative graphs of percent prey composition (PPC) and percent minimum number (PMN) for nine prey and the categories other fishes, other cephalopods, and questionable identifications that were found in 669 California sea lion scats collected at San Clemente Island, California from April 1983 through September 1985.

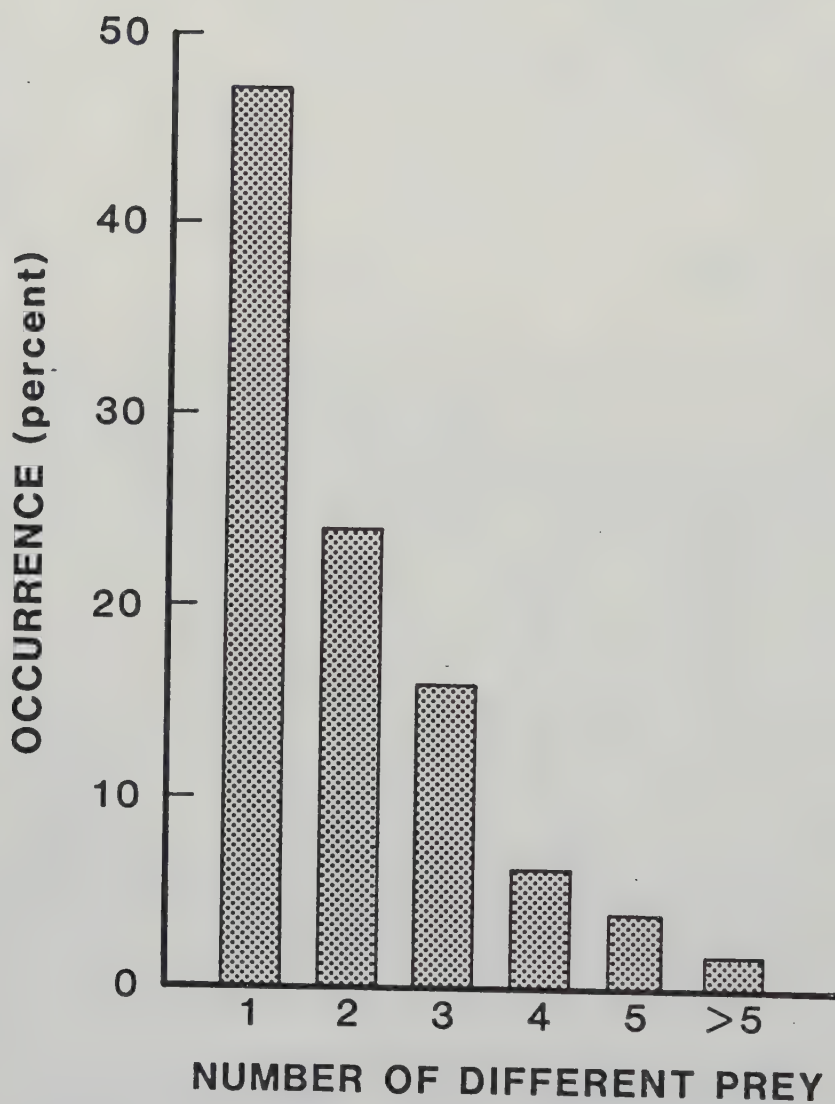


Figure 3. Occurrence of single and multiple prey in 766 California sea lion scats collected at San Clemente Island, California during 20 sampling periods from April 1983 through September 1985.

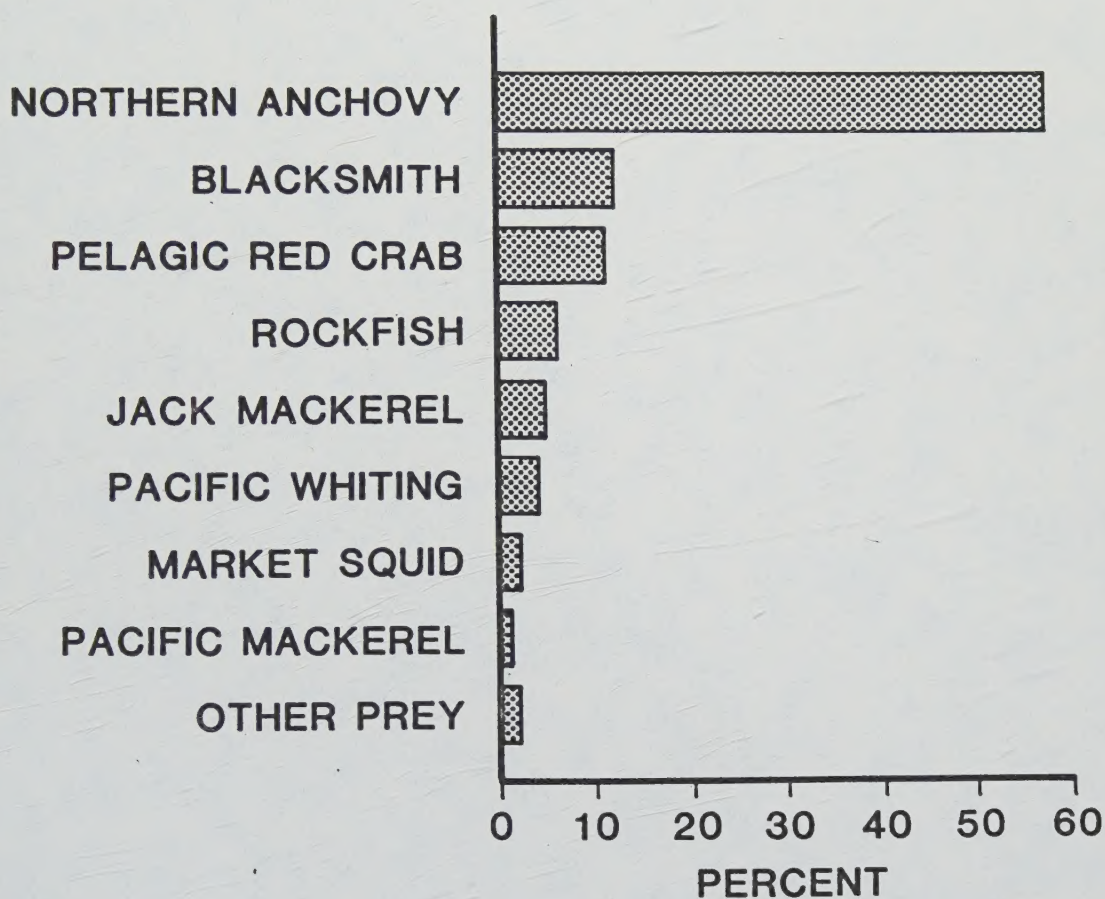


Figure 4. The prey (%) found in 361 California sea lion scats with single prey items out of 766 scat samples collected at San Clemente Island, California from April 1983 through September 1985.

